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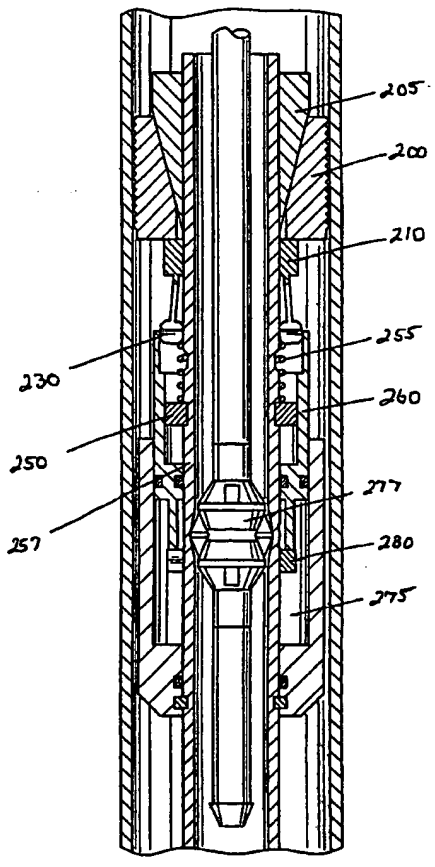
(54) Title: TOOLS AND METHODS FOR USE WITH EXPANDABLE TUBULARS



(57) Abstract: In one aspect of the invention, tools are actuated or operated within a well by selectively expanding the tool wall. To actuate the tool, the tool wall (225) is urged outward past its elastic limits. The expanding wall physically unlocks a locking ring (280) which then ulocks a piston (260). Thereafter, hydraulic pressure difference are employed to move the piston to operate the downhole tool. In another aspect of the invention, a first piece of casing is joined to a second, larger diameter casing. By expanding the diameter of the first piece of casing into contact with the second piece of casing, the two are joined together. The joint is formed with helical formations in a manner that provides flow paths around the intersection of the two members for the passage of cement or other fluid.

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TOOLS AND METHODS FOR USE WITH EXPANDABLE TUBULARS

The present invention relates to expanding tubulars in a well and more particularly, to methods and tools utilising technology directed towards downhole expansion of tubulars.

There are many types of operations that must be performed at some depth in a well and various tools and methods have been developed to perform these downhole operations. Downhole tools for example, are available with means for setting after being placed at some depth in a well. The tools are actuated in order to fix or set them in place in the well. In some cases, setting involves the setting of a slip to secure the position of the tool against the casing walls. For example, with casing liner, one string of casing is hung in the well at the end of a previous string and the liner must be set at the appropriate depth by actuating slips against the inner wall of the existing casing. In another example, a packer used to isolate an annular area between two tubular members, is set at a particular depth in a well prior to expanding its surfaces against the inner tube and the outer tube walls.

There are numerous known ways to set downhole tools. Typically, pressure build-up inside or outside the tool is required. In some prior art tools, that pressure is typically communicated through a wall of the tool into a sealed chamber. An actuating piston forms part of the sealed chamber such that the cavity will grow or shrink in volume as the piston moves responsive to the increase or decrease of hydraulic pressure within the tool. These variable-volume cavities outside the wall of the tool are sealed off with eleastomeric O-rings or similar seals. The seals are subject to wear from contamination in wellbore fluids, stroking back and forth in normal operation, and/or temperature or chemical effects from the wellbore fluids. The biggest concern about seal wear is that an open channel could be created through the lateral port in the wall of the tool from inside to outside of the tool, thus upsetting well operations and costing critically expensive downtime for the well operator.

A more recent advance, described in U.S. patent no. 5,560,426 employs the principles of pressure differential but without fluid communication throughout he wall

of the tool. Instead, the applied pressure differential creates a stress which allows the wall of the tool to flex and fracture a locking ring on the outside surface of the tool. When the ring fractures, a piston moves in reaction to the pressure differential and a spring loaded slip is driven onto a cone, thereby setting the tool in the well. While this technology is an improvement over those requiring an aperture in the tool wall, the structure and mechanical operations required are complicated and subject to failure. For example, in the apparatus described in patent no. 5,560,426, an atmospheric chamber is formed on the inside of the tool body as well as the outside. To begin the tool setting sequence, the outer chamber must be opened to the pressure of the well. Opening the outer chamber is performed by dropping a ball into a seat formed at the top of the chamber and then increasing pressure inside of the tubing and body until the ball, seat and chamber are blown down into the well bore. Assuming that the interior chamber is successfully opened to well pressure, the design also requires a flexing of the tool wall in order to fracture a frangible locking ring. The required flexing that must take place in the wall is difficult to calculate and predict when designing the tool and the locking ring.

Other problems associated with current downhole tools are related to space. A liner hanger with its slips and cones necessarily requires a certain amount of space as it is run-into the well. This space requirement makes it difficult to insert a liner hanger through previously installed tools like mechanical packers because the inside diameter of the previously installed tool is reduced. Space problems also arise after a slip and cone tool is set in a well because adequate clearance must be available for the subsequent flow of liquids like cement through the annular area between the tubulars.

Technology is emerging for selectively expanding the diameter of tubing or casing in a well. Figure 1 depicts an expansion apparatus 100 which can be lowered into a well to a predetermined location and can subsequently be used to expand the diameter of the tubular member. The apparatus 100 comprises a body having two spaced-apart, double conical portions 102a,b with rollers 105 mounted therebetween. The rollers 105 may be urged outwards by application of fluid pressure to the body interior via the running string 103. Fluid pressure in the running string urges the conical portions 102a, b towards each other and forces the rollers 105 into contact with a wall

107 of a tubular member 110 sufficient to deform the wall of the tubing. Each roller 105 defines a circumferential rib 115 which provides a high pressure contact area. Following the creation of an expanded area 120 visible in Figure 2, the fluid pressure in communication with the apparatus is let off, allowing the rollers 105 to retract. The apparatus 100 is then moved axially a predetermined distance to be re-energized and form another expanded area or is removed from the well. In the embodiment shown in Figures 1 and 2, the portions contacting the tube wall are rollers. However, the portions contacting the tubular wall could be non-rotating or could rotate in a longitudinal direction allowing the creation of a continued area of expansion within a tubular body.

There is a need therefore, for a slip and cone tool which requires less space as it is inserted into the well.

There is a further need for a slip and cone tool that requires less space after it has been set in the well.

There is a further need for downhole tools that utilize a removable expansion apparatus for activation.

There is a further need for a method of expanding a tubular wall in a well when the portion of the tubular to be expanded is located below a previously set, non collapsible tool.

There is a further need for a downhole tool that can be operated or set in a wellbore by simple, remote means.

There is a further need for a downhole tool that can be operated or actuated without the use of chambers.

There is a further need for a downhole tool that can be operated without the use of gravity feed balls or other objects dropped from the earth's surface.

According to a first aspect of the present invention, there is provided a tool for performing a downhole operation, comprising:

a tubular body forming a wall, the wall having an interior which defines a passage therein and an exterior which, when placed in the wellbore, defines an annular space therewith;

an actuating member movably mounted on the outside of the wall for performing the downhole operation; and

a locking member mounted on the outside of the wall to selectively prevent motion of said actuating member until said locking member is unlocked responsive to expansion of the wall of the tubular body.

Further aspects and preferred features of the invention are set out in claims 2 to 16.

The invention relates to methods, apparatus and tools to be used with tubular expansion apparatus. In one aspect of the invention, tools are actuated or operated within a well by selectively expanding the tool wall. More specifically, a tool, like a casing liner hanger is provided with a chamber formed on the exterior surface of the tool creating a pressure differential within the tool. A locking ring around the outside of the tool body normally locks the piston in place. To actuate the tool, the tool wall is urged outward past its elastic limits. The expanding wall physically unlocks a locking ring which then unlocks the piston. Thereafter, hydraulic pressure differences are employed to move the piston to operate the downhole tool. In another aspect of the invention, a tool includes a cone formed thereupon and a multi-part slip disposed around the tool body. To operate the tool, the body is expanded at a first end of the slip and then expanded in an axial direction towards the cone. In this manner, the slip is forced onto the cone by the expanding body and the tool thereby set against the casing wall. In another aspect of the invention, a body is formed with a cone having teeth thereupon. To set the tool, the body of the tool is expanded directly under the toothed cone so as to force the teeth of the cone into contact with the casing wall to set the tool. In yet another aspect of the invention, a first piece of casing is joined to a second, larger diameter casing. By expanding the diameter of the first piece of casing into contact with the second piece of casing, the two are joined together. The joint is formed with

helical formations in a manner that provides flow paths around the intersection of the two members for the passage of cement or other fluid.

Some preferred embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 is a is a section view showing an expansion apparatus;

Figure 2 is a is a section view showing an expansion apparatus in an actuated state;

Figure 3 is a section view showing an unactuated tool of the present invention;

Figure 3a is a section view showing the tool of Figure 3 in an actuated state;

Figure 4 is a section view showing another embodiment of the present invention;

Figure 5 is a section view showing another embodiment of the present invention;

Figure 5a is a section view showing the tool of Figure 5 in an actuated position;

Figure 6 is a section view showing another embodiment of the present invention;

Figure 7 is a section view showing another embodiment of the present invention;

Figure 8 is a section view showing yet another embodiment of the present invention;

Figure 9 is a section view showing an expansion apparatus;

Figure 10 is a view showing tubing with a helical formation formed therein; and

Figure 11 is a section view showing various lengths of tubing having been expanded.

A first embodiment of the invention is shown in Figure 3. For illustrative purposes, the tool is shown in use with a casing lining hanger. However, those skilled in the art will appreciate that the tool described and claimed herein can be used to perform any number of tasks in a well wherein simple, reliable and remote actuation or operation is required. The casing line hanger in Figure 3 includes a mechanism for setting a number of slips 200 by pushing them along a cone 205. In the run-in position shown in Figure 3, the slips 200 are retracted to facilitate the insertion of the downhole tool in the wellbore. Ultimately, as can be seen by comparing Figures 3 and 3A, the slips 200 will be driven up the sloping surface of cone 205. The slips 200 are held by a retainer 210, which in turn abuts a piston assembly 215. Piston assembly 215 includes a piston 260, a lug 230, which in the run-in position is trapped in groove 270 by sleeve 240. Sleeve 240 abuts lug 230 on one end, while the other end of lug 230 is in groove 270, thus effectively trapping the piston assembly 215 from longitudinal movement. A support ring 250 is secured to the wall 255 of the tool. The support ring 250 supports a spring 255, which, when the lug 230 is liberated by movement of sleeve 240, results in biasing the piston 260 in a manner which will drive the slips 200 up the cone 205, as shown in Figure 3A.

Piston assembly 215 has an extending segment 265 which extends into an atmospheric chamber 275. The pressure in chamber 275 is preferably atmospheric, but can be a different pressure up to near the annulus pressure. Because the hydrostatic pressure acting on piston assembly 215 in the wellbore exceeds the opposing pressure exerted on extending segment 265 within cavity 275, piston assembly 215 tends to want to move downward against lock ring 280.

In the preferred embodiment, the locking ring is broken when the wall of the tool is expanded by a radial force transmitted from inside the wall. This expansion of the tool wall by an apparatus like the mechanism shown in Figures 1 and 2 puts an increasing stress on lock ring 280, causing the lock ring, which can be preferably of a ceramic material, to break. Since the piston assembly 215 is in a pressure imbalance and the pressure internally in chamber 275 is significantly lower than the hydrostatic pressure in the annulus outside the tool, the piston assembly 215 shifts further into the chamber 275, as illustrated in Figure 3A. Once sufficient movement into chamber 275

has resulted in a liberation of lug 230, spring 255 moves the piston assembly 215 upwardly, thus camming the slips 200 up the cone 205.

In a second embodiment of the invention, the atmospheric chamber in the tool is formed in such a way as to make the spring loaded function of the tool unnecessary. Figure 4 depicts the second embodiment in its unset or run-in position. A piston 405 is held in a locked position within a chamber 407 by a locking ring 410 that is seated in a groove 415. Unlike the previous embodiment, the piston is arranged in such a way that when actuation of the tool is initiated by breaking the locking ring 410 and allowing the piston 405 to travel in response to the pressure differential, an arm 420 formed at the end of the piston 405 directly contacts the slip 425 and forces the slip upon the cone 430, thereby setting the tool. The embodiment herein described avoids the use of a spring loaded mechanism, saving parts and expense and complexity. As in the embodiment of Figures 3 and 3A, the locking ring is fractured by a radial force applied to the interior wall 440 of the tool by an expansion apparatus 460.

Another embodiment of the invention is shown in Figures 5 and 5A. In this embodiment, the tool consists of a body 505, a multi-piece slip 510 disposed around the body and attached to a ring 516 and a cone 515 mounted on the outer surface of the body. The slip assembly 510 includes toothed members constructed and arranged to contact the wall of the casing when the tool is set. In this embodiment, the tool also includes a slight undulation or profile 512 in the tool body under a cut-out portion 511 of ring 516. The profile 512, in the preferred embodiment, is formed in the tool wall at the surface of the well and houses a roller of the expansion apparatus 550 in a partially energized state. By pre-forming the profile 512, the apparatus 550 is located at the correct location with respect to the tool body and the profile 512 additionally retains the tool in the unset or run-in position.

In order to operate the tool of this embodiment, the expansion apparatus 550 is energized at the location of the profile. Thereafter, the expansion apparatus is urged upwards while energized. The apparatus may also be rotated while it is being urged upwards. As the tool is pulled, the profile 512 assumes the shape shown in Figure 5A as it is axially extended in the direction of the cone 515. In this manner the slips 510

are urged onto the cone thereby pressing the toothed portion of the slip against the casing wall to set the hanger. When the slip has moved far enough onto the cone for the hanger to be securely set, the expansion tool is de-energized and removed from the well bore.

In another embodiment depicted in Figure 6, a liner hanger 600 includes a body 602 and a cone 605 formed thereupon. Disposed around the body is a ring 650 having a groove 610 formed in its inner surface 612 which aligns with a groove 615 formed on the outer surface 617 of the body 602. A locking ring 608 held in the grooves 610, 615 prevents the ring 650 from moving in relation to the body. The ring 650 is further suspended within the wall of casing 620 by means of at least two leaf springs 622 mounted on the outer surface of the ring 650. In this embodiment, when the lock ring 608 is broken due to expansion of the tool body by an expansion apparatus 650, the frictional relationship between the ring 650 and the casing wall 620 causes the ring 650 to remain stationary in the wellbore The liner is thereafter set when the tubing string and tool body 602 is pulled upwards and the slip is driven onto the cone.

In yet another embodiment of the invention illustrated in Figure 7, a slip actuated gripping device like a liner hanger 700 for example, is provided having a body 702 without a cone initially formed thereon. In this embodiment, a cone for setting the slip is formed in the wellbore using an expansion apparatus with the capability of expanding a tubular to various, gradually increasing diameters. In the preferred embodiment, slip assembly 710 consisting of a ring and slips is disposed around body 702 and retained during run-in by two rings 708a, b. Slip assembly 710 is also suspended within annulus 711 by at least two leaf springs 712 in frictional relation with the inner wall 714 of tubular member 741 and the outer surface 742 of slip assembly 710. The expansion apparatus 705 is then energized at a predetermined location opposite the slip assembly 710. As the apparatus 705 is moved upwards in the well and rotated, the rollers 715 extend outwards in a gradually increasing manner, thereby forming a cone 730 that is slanted in the direction of the slip assembly 710. After the expansion apparatus 705 is de-energized and removed, the liner hanger 700 is set by lowering the body 702 in relation to the stationary slip assembly 710. Due to the absence of a cone formed on the liner hanger at the time of run-in, the tool of this

embodiment has a reduced outer diameter and may be passed through a smaller annular area than prior art liners having a cone. While in the preferred embodiment the cone is formed in the direction of the well surface, it will be understood that the formation of a continuous expanded diameter can be made in any direction

In yet another embodiment of the invention depicted in Figure 8, a first smaller diameter tubular 802 is expanded directly into engagement with the inner surface 805 of a larger diameter tubular 807. In this embodiment, the expansion apparatus includes a roller capable of extending the wall of the first tubular 802 the entire width of the annular area 820 between the two tubulars 802, 807. In the preferred embodiment, that portion of smaller diameter tubular 802 to be expanded into contact with the outer tubular, includes teeth 825 formed thereupon or some other means to increase grip between surfaces.

In another embodiment of the invention shown in Figures 9 and 10, a series of helical grooves 902 are formed in a wall 904 of a tubular member 906 through the use of an expanding member having rollers mounted in a helical fashion as shown in Figure 9. Specifically, the expansion apparatus 900 includes expandable rollers 908 that extend around the circumference thereof in a helix. The rollers 908 are constructed and arranged to extend outward as the apparatus is energized so as to come into contact with and exert a radial force upon the inside wall 910 of a tubular member 906. As the expansion apparatus 900 is rotated and moved in an axial direction, a helical formation is left on the inner 910 and outer 912 walls of the tubular member 906. This embodiment is particularly advantageous for making a connection between two pieces of casing in a manner that provides channels for the subsequent flow of drilling fluid or cement. The angle and depth of the helical grooves is variable depending upon well conditions and will be determined somewhat by the size of the annular area between two pieces of tubing to be joined together. In the embodiment described, rollers are used as the point of contact between the expansion apparatus and the tubular wall. However, the shape and configuration of the expansion apparatus members contacting and exerting a radial force upon the wall of tubulars in this and any other embodiment herein are not limited.

Figure 11 demonstrates yet another method of expanding a tubular downhole. A non-collapsible mechanical packer 950 is located at a first location in the well and below that packer are various strings of tubulars including solid tubing 952, slotted liner 954 and sand screen 956. An expansion apparatus may be selectively inserted into the well through the reduced diameter of the mechanical packer 950 and the various tubulars may then be expanded. Thereafter, the apparatus can then be removed from the well without damaging the mechanical packer.

While the foregoing is directed to the preferred embodiment of the present invention, other and further embodiments of the invention may be devised without departing from the basis scope thereof, and the scope thereof is determined by the claims that follow.

CLAIMS:

1. A tool for performing a downhole operation, comprising:

a tubular body forming a wall, the wall having an interior which defines a passage therein and an exterior which, when placed in the wellbore, defines an annular space therewith;

an actuating member movably mounted on the outside of the wall for performing the downhole operation; and

a locking member mounted on the outside of the wall to selectively prevent motion of said actuating member until said locking member is unlocked responsive to expansion of the wall of the tubular body.

2. The tool of claim 1, whereby the actuating member is a spring.

3. The tool of claim 1, whereby the actuating member includes a piston and an atmospheric chamber.

4. An apparatus for performing a downhole operation from the surface of a well, comprising:

a tubular body forming a wall, said wall having an interior which defines a passage therein and an exterior which, when placed in the wellbore, defines an annular space therewith;

a ring member disposed around the body, the ring member including a plurality of slips and held in frictional contact with an inner surface of an outer casing by a spring;

a locking member mounted to the wall of the tool to selectively prevent motion of said ring until said locking member is unlocked responsive to expansion of the wall of the tubular body; and

removable means within the passage for expanding the wall of the tubular body, thereby unlocking the tool.

5. The apparatus of claim 4, whereby the apparatus is set by lowering the body in relation to the ring and slips after the tool is unlocked.

6. The apparatus of claim 4 or 5, wherein the removable means within the passage for expanding the wall tubular body can form a cone shape in the wall, the cone shape formed for receiving the slips.

7. An apparatus for performing a downhole operation from the surface, comprising:

a tubular body forming a wall, said wall having an interior which defines a passage therein and an exterior which, when placed in the wellbore, defines an annular space therewith;

a cone formed on the outside surface of the body;

a ring member and at least one slip disposed around the body;

a groove formed in the inside of the ring outwardly extending profile formed in the wall of the body under the groove; whereby

the tool is set by expanding the profile through a radial force applied to the wall in the direction of the cone, thereby forcing the slip onto the cone.

8. An apparatus for performing a downhole operation from the surface, comprising:

a tubular body forming a wall, said wall having an interior which defines a passage therein and an exterior which, when placed in the wellbore, defines an annular space therewith;

at least one surface of the outer surface of the body having grip enhancing material attached thereto; whereby

the tool is actuated when the wall of the tool is expanded into contact with the inside surface of another, larger diameter tubular member.

9. A method of forming helical grooves in a tubular member in a well, the method comprising the steps of:

placing a tool having a cone shaped body in the interior of the tubular member;

energizing a plurality of rollers in the body whereby the rollers provide a radial force against the wall of the tubular member, the rollers having a helical geometry; and

rotating and advancing the tool within the tubular member to form the helical forms in the tubular.

10. A method of selectively expanding a tubular comparing the steps of:

extending a tool into a well bore through a non compressible member; thereafter,

energizing a plurality of rollers to create a radial force against the tubular;

expanding the tubular in one or more places;

retracting the rollers; and

removing the tool through the non compressible member.

11. A method of changing the state of a down hole tool in a well comprising the steps of:

providing a tool at a predetermined location in a well, the tool including a tubular body with a cone formed thereupon, a ring disposed around the body with a plurality of slips extending therefrom, a setting mechanism to urge the slips up the cone and a locking mechanism on the body of the tool to prevent premature setting of the tool;

placing an expansion apparatus in the body of the tool, the expansion apparatus including at least one energizable member capable of placing a radial force upon the inside wall of the tool body; and

energizing the member at a location in the tool opposite the locking mechanism, thereby causing the setting mechanism to urge the slips up the cone.

12. The method of claim 11, wherein the energized member indirectly causes the setting mechanism to urge the slips up the cone.

13. A method of changing the state of a tool in a well, comprising the steps of:

providing a tool in a first state having:

a body,

a state-changing mechanism,

a locking mechanism to keep the tool in the first state;

proving an expansion apparatus with an expansion mechanism in the interior of the tool; and

energizing the expansion mechanism of the expansion apparatus thereby exerting a radial force on the body of the tool and unlocking the locking mechanism, and thereby causing the tool to advance to a second state.

14. A method of selectively expanding a tubular in a wellbore comprising the steps of:

(a) placing an expansion member at a first predetermined location within the tubular to be expanded;

(b) energizing the expansion member to exert a radial force upon an inside wall of the tubular, thereby expanding an inside and outside diameter of the tubular at the first predetermined location; and

(c) de-energizing the expansion member.

15. The method of claim 14 further including the step of moving the expansion member within the tubular to a second predetermined location and re-energizing the expansion member, thereby expanding the inside and outside diameter of the tubular at the second predetermined location.

16. The method of claim 14 further including the step of moving the energized expansion member axially within the tubular, thereby lengthening the expanded diameter portion of the tubular.

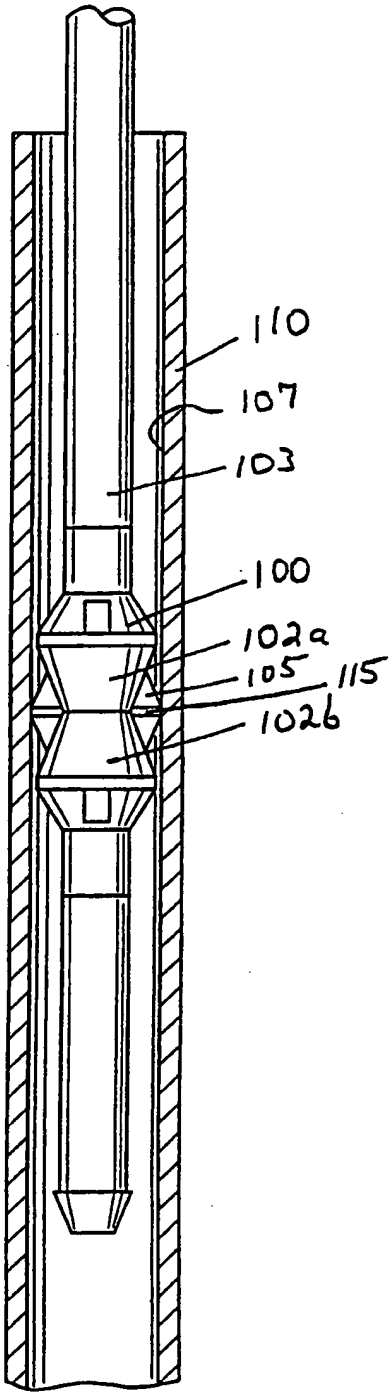

FIG. 1

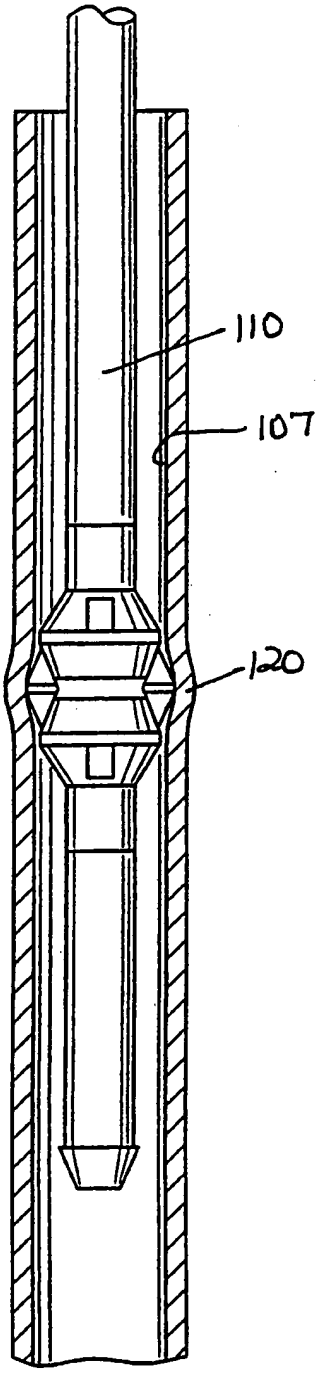

FIG.2

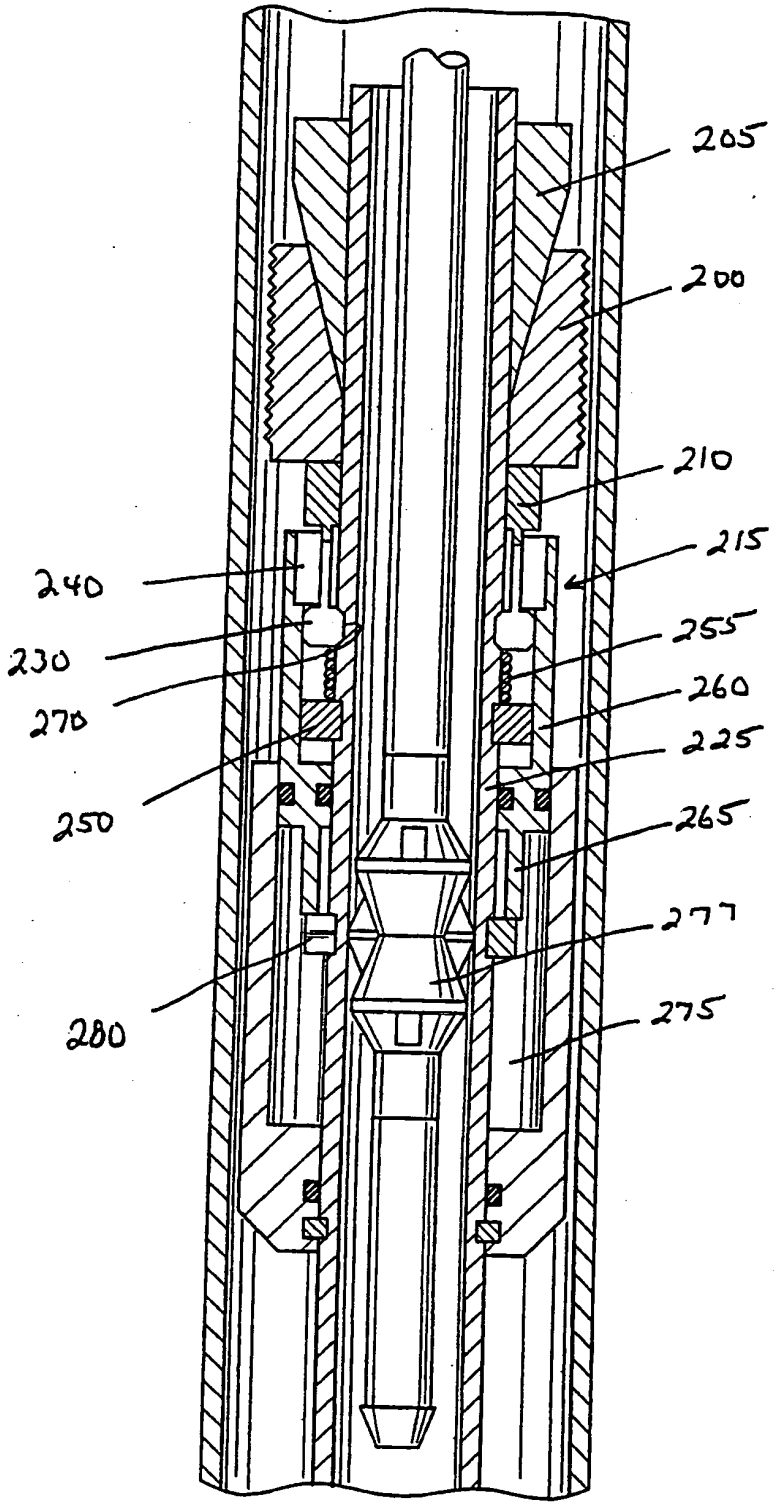

FIG.3

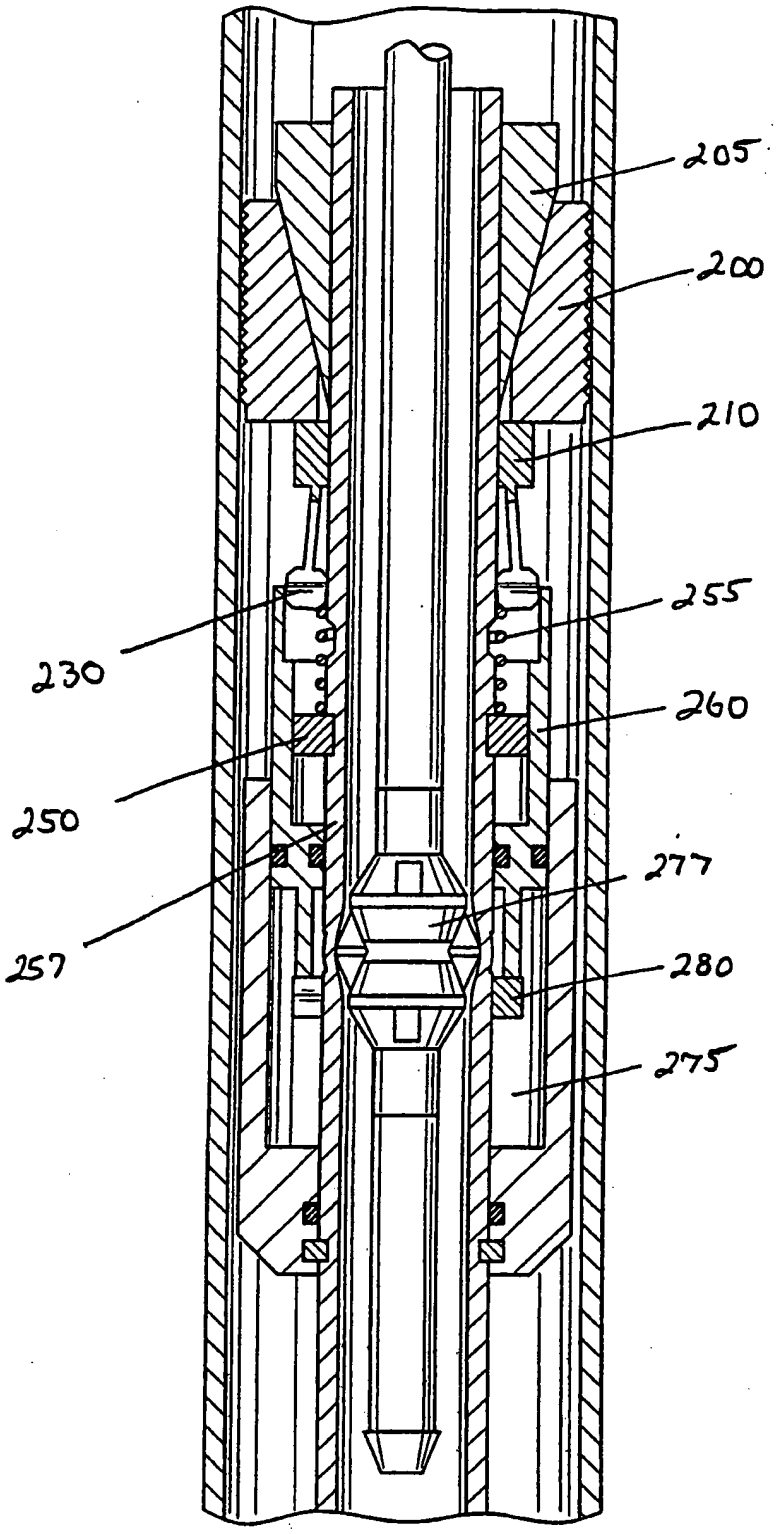

FIG.3A

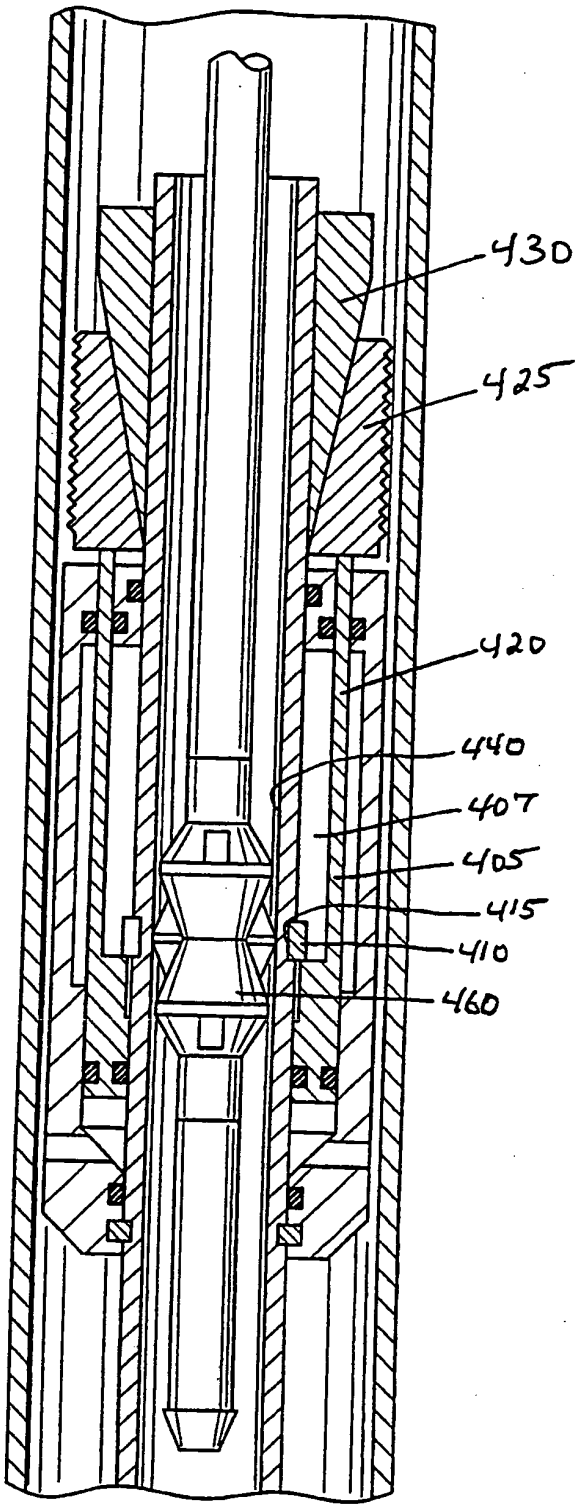

FIG. 4

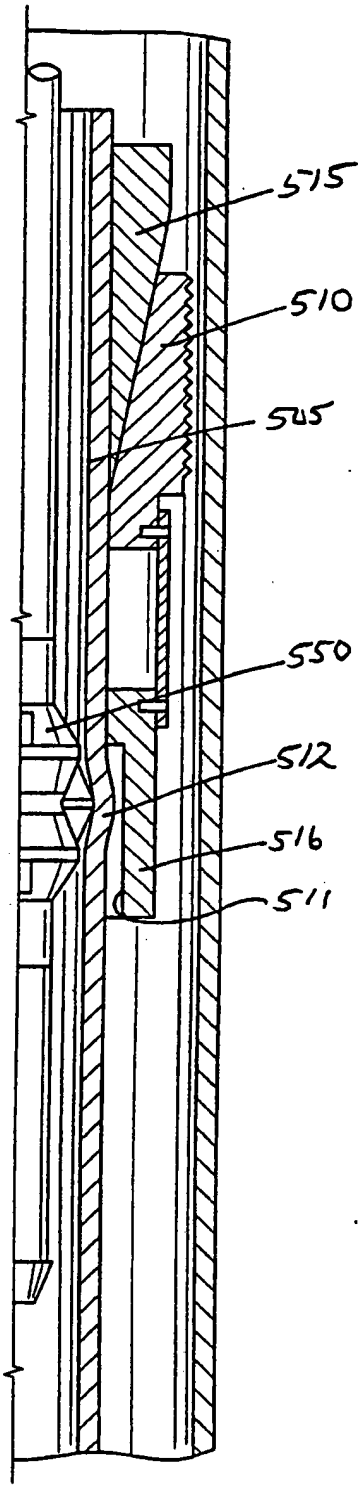

FIG.5

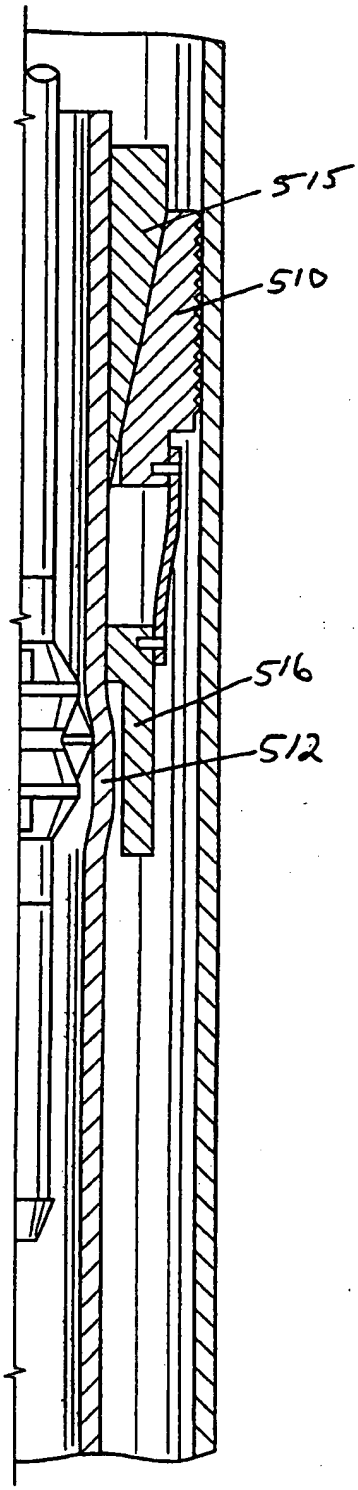

FIG.5A

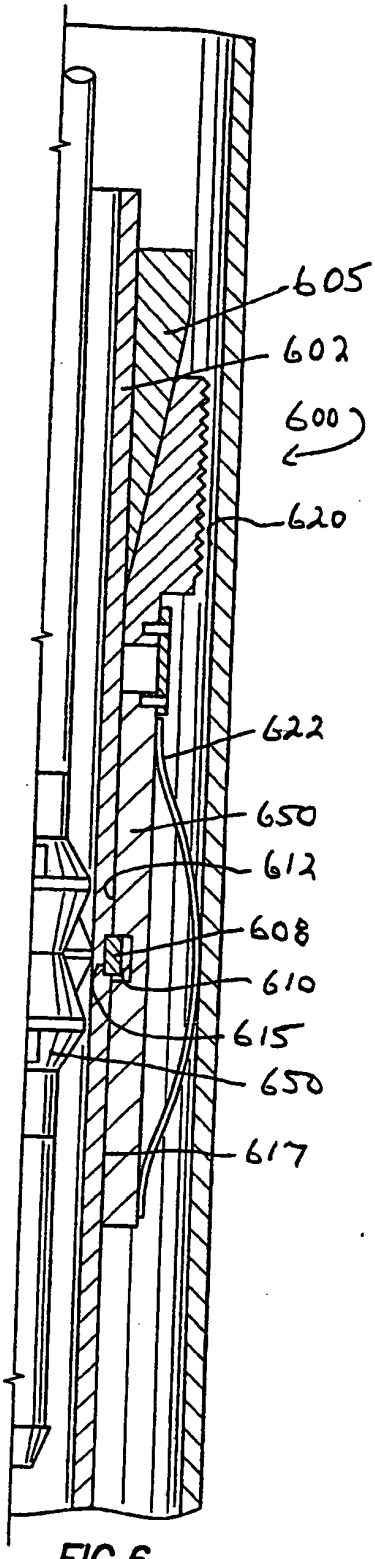
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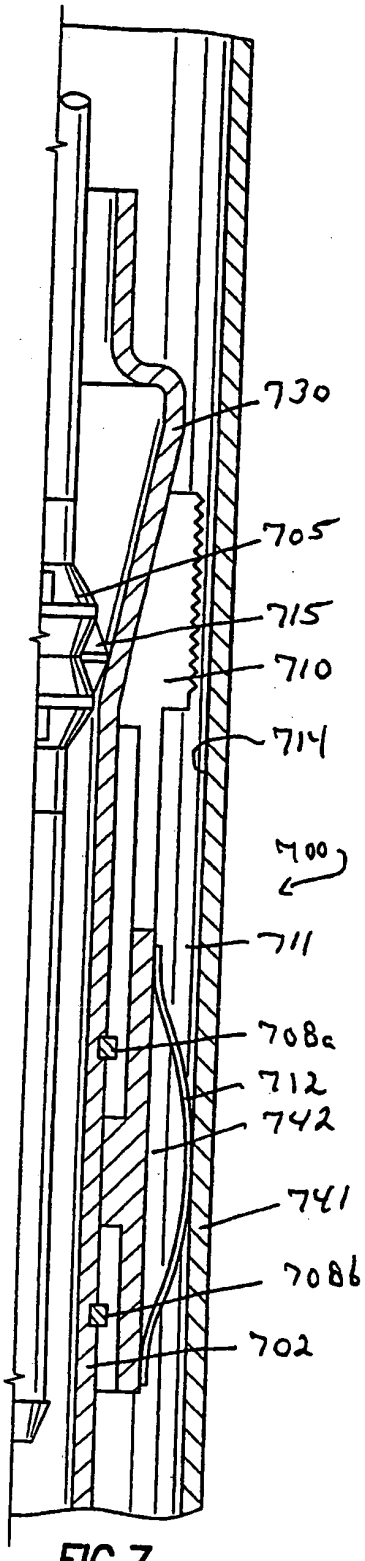
FIG.6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708b
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FIG.7

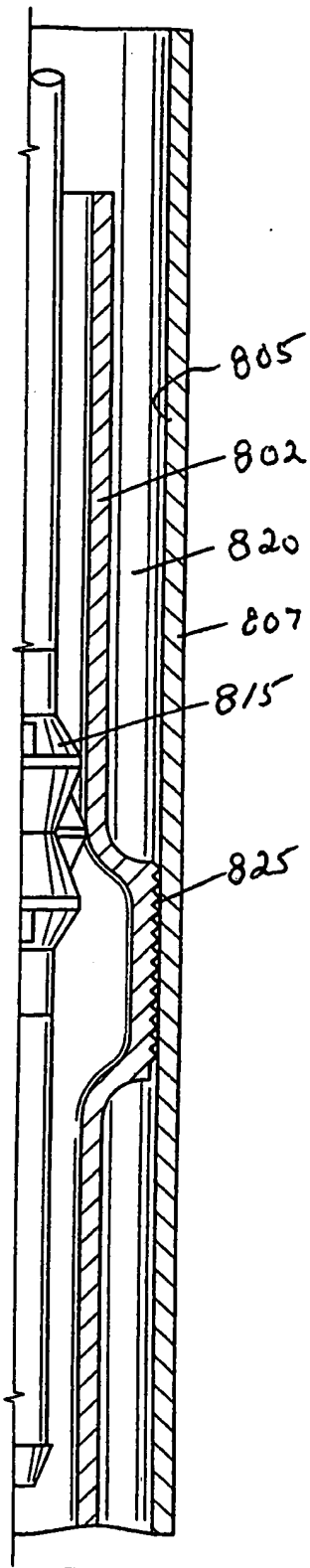

FIG.8

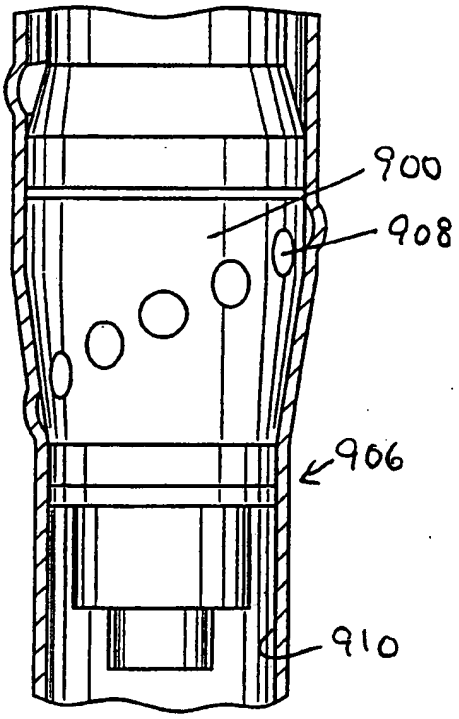

FIG.9

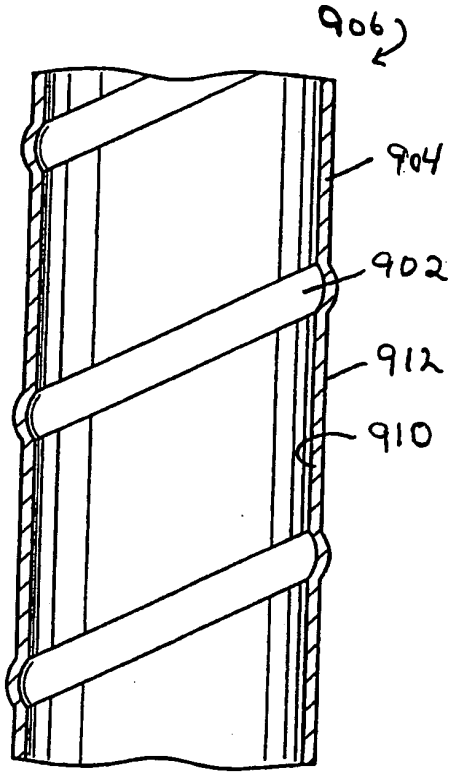

FIG. 10

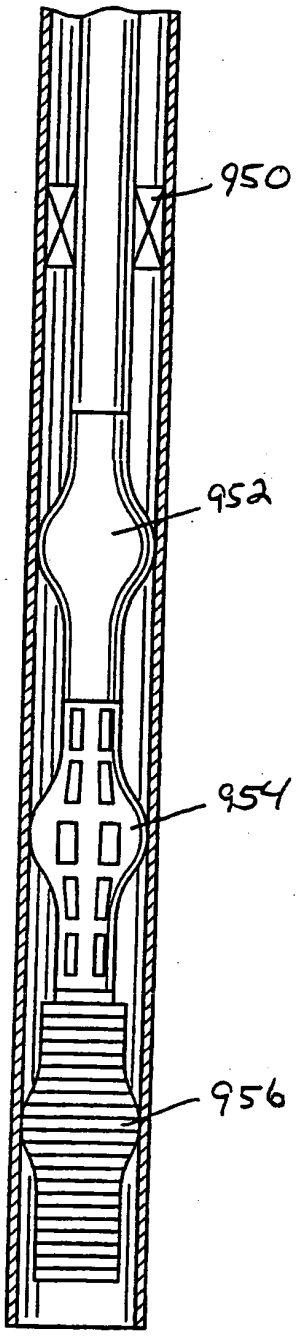

FIG. 11

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/04160

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B23/00 E21B43/10 E21B23/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 560 426 A (TRAHAN KEVIN O ET AL) 1 October 1996 (1996-10-01) cited in the application	1-3,13
Y A	column 1, line 46 - line 54 column 3, line 2 - line 38 column 4, line 62; figures 1-3	4,5 7,8,11, 12

Y	US 3 195 646 A (BROWN, C.C.) 20 July 1965 (1965-07-20) column 3, line 6 - line 25; figures 1,2	4,5

A	US 4 848 469 A (BAUGH J LINDLEY ET AL) 18 July 1989 (1989-07-18) column 6, line 47 - line 58	4,5

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 January 2001	18. 04. 01

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bellingacci, F

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/04160

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 961 007 A (HALLIBURTON ENERGY SERV INC) 1 December 1999 (1999-12-01) column 21, line 37 - line 42; figures 6A,6B,7 column 24, line 43 - line 51 ---	8
X	GB 2 320 734 A (BAKER HUGHES INC) 1 July 1998 (1998-07-01) page 13, line 12 - line 20; figures 2,3 -----	8

2

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 00/04160

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-8, 11-13

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-8,11-13

1.1. Claims: 1-6, 11-13
Apparatus for performing a downhole operation, the apparatus comprising a locking member preventing the downhole operation from happening, the locking member being releasable by expanding a wall of the apparatus.

1.2. Claim : 7
Apparatus for performing a downhole operation, the apparatus comprising a wall provided with an extending profile, the downhole operation being performed by expanding the extending profile so as to drive a set of slips onto a cone.

1.3. Claim : 8
Apparatus for performing a downhole operation, the apparatus comprising a wall having grip enhancing means material attached thereto, the tool being actuated when the wall of the tool is expanded into contact with the inside surface of a larger tubular.

2. Claims: 9, 10, 14-16

Method of expanding a tubular in a wellbore.

Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/04160

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5560426 A	01-10-1996	AU 706602 B	17-06-1999
		AU 4814596 A	10-10-1996
		CA 2171358 A	28-09-1996
		DK 35196 A	28-09-1996
		GB 2300207 A,B	30-10-1996
		NL 1002726 C	15-10-1996
		NL 1002726 A	30-09-1996
		NO 961225 A	30-09-1996
US 3195646 A	20-07-1965	NONE	
US 4848469 A	18-07-1989	NONE	
EP 0961007 A	01-12-1999	US 6135208 A	24-10-2000
		US 6189616 B	20-02-2001
GB 2320734 A	01-07-1998	AU 4834797 A	18-06-1998
		CA 2224668 A	14-06-1998
		NO 975894 A	15-06-1998